SLOVENSKI STANDARD

SIST EN ISO 3381:2005

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Železniške naprave – Akustika – Merjenje hrupa v tirnih vozilih (ISO 3381:2005)

Railway applications - Acoustics - Measurement of noise inside railbound vehicles (ISO 3381:2005)

Bahnanwendungen - Akustik - Geräuschmessungen in spurgebundenen Fahrzeugen (ISO 3381:2005)

Applications ferroviaires - Acoustique - Mesurage du bruit a l'intérieur des véhicules circulant sur rails (ISO 3381:2005)

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English Version

Railway applications - Acoustics - Measurement of noise inside railbound vehicles (ISO 3381:2005)

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This European Standard was approved by CEN on 19 May 2005.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This European Standard (EN ISO 3381:2005) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 43 "Acoustics".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2006, and conflicting national standards shall be withdrawn at the latest by February 2006.

This document has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 96/48.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the conditions for obtaining reproducible and comparable measurement results of levels and spectra of noise inside all kinds of vehicles on rails or other types of fixed track, hereinafter conventionally called “train”, except for track maintenance vehicles in operation.

This standard is applicable for:

— type testing;

— periodic monitoring testing.

The results may be used, for example:

— to characterise the noise inside these vehicles;

— to compare the internal noise of various vehicles on a particular track section.

The test procedures specified in this European Standard are of engineering grade (grade 2, with a precision of ± 2 dB), that is the preferred one for noise declaration purposes, as defined in EN ISO 12001.

The standard describes tests during different operating conditions, i.e. driving, accelerating, decelerating and standstill. The chosen operating conditions are decided by the relevant authority or the train owner/operator. It is not mandatory to perform tests at all conditions.

Infrasound and messages intelligibility are not treated in this standard.

The procedures specified for accelerating and decelerating tests are of survey grade.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references the latest edition of the referenced document (including any amendments) applies.

EN 60942, *Electroacoustics — Sound calibrators (IEC 60942:2003)*

EN 61260, *Electroacoustics — Octave-band and fractional-octave-band filters (IEC 61260:1995)*

EN 61672-1:2003, *Electroacoustics — Sound level meters — Part 1: Specifications (IEC 61672-1:2002)*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1
type test for noise emission of railbound vehicles
type test
measurement performed to prove that, or to check if, a vehicle delivered by the manufacturer complies with the noise specifications

3.2
monitoring test for noise emission of railbound vehicles
monitoring test
measurement performed to check that the noise of one or more vehicles, taken among individual units in a consignment of vehicles, is within prescribed limits or to check if the noise of the vehicle has changed since initial delivery or after modification

3.3
roughness
r
root mean square (RMS) value of the amplitude variation of the running surface of a rail in the direction of motion (longitudinal level) measured over a rail length, expressed in μm

3.4
roughness level
L_r
level given by the equation:

$$L_r = 10 \lg (r/r_0)^2 \text{ dB} \quad (1)$$

where

L_r is the roughness level in dB;

r is the RMS roughness in μm;

r_0 the reference roughness; r_0 =1 μm.

This definition applies to values measured either as a wavelength spectrum or in a particular wavelength band centred at λ (expressed in m)

3.5
sound pressure
$p(t)$
root mean square (RMS) value of a fluctuating pressure superimposed on the static atmospheric pressure measured over a certain time period, expressed in Pa

3.6
sound pressure level
L_p
level given by the equation:

$$L_p = 10 \lg (p(t)/p_0)^2 \text{ dB} \quad (2)$$

where

L_p is the sound pressure level in dB;

$p(t)$ is the RMS sound pressure in Pa;

p_0 the reference sound pressure; p_0. = 20 μPa.

NOTE Definitions from 3.6 to 3.11 apply to values measured either as a frequency spectrum or in a particular frequency band of centre *f* (expressed in Hz).

3.7
A-weighted sound pressure level
L_{pA}
sound pressure level obtained by using the frequency weighting A (see EN 61672-1), given by the following equation:

$$L_{pA} = 10 \lg \left(p_A(t) / p_0 \right)^2 \text{ dB} \quad (3)$$

where

L_{pA} is the A-weighted sound pressure level in dB;

$p_A(t)$ is the RMS A-weighted sound pressure in Pa;

p_0 the reference sound pressure; p_0. = 20 μPa.

3.8
AF-weighted maximum sound pressure level
L_{pAFmax}
maximum value of the A-weighted sound pressure level determined during the measurement time interval T by using time weighting fast F

[EN 61672-1]

3.9
A-weighted equivalent continuous sound pressure level
$L_{pAeq,T}$
A-weighted sound pressure level given by the following equation:

$$L_{pAeq,T} = 10 \lg \left(\frac{1}{T} \int_0^T \frac{p_A^2(t)}{p_0^2} dt \right) \text{dB} \quad (4)$$

where

$L_{pAeq,T}$ is the A-weighted equivalent continuous sound pressure level in dB;

T is the measurement time interval in s;

$p_A(t)$ is the A-weighted instantaneous sound pressure in Pa;

p_0 the reference sound pressure; p_0= 20 μPa.

3.10
A-weighted short-term equivalent continuous sound pressure level
$L_{pAeq,1s}$
A-weighted equivalent continuous sound pressure level (see 3.9) where the measurement time interval T is one second (T = 1s)

3.11
A-weighted equivalent continuous impulsive sound pressure level
L_{pAIeqT}
A-weighted equivalent continuous sound pressure level determined by using time weighting impulse I (see EN 61672-1) given by the following equation:

$$L_{p\mathrm{Aleq},T} = 10\lg\left(\frac{1}{T}\int_0^T \frac{p_{\mathrm{AI}}^2(t)}{p_0^2}\mathrm{d}t\right)\mathrm{dB} \qquad (5)$$

where

$L_{p\mathrm{Aleq},T}$ is the A-weighted equivalent continuous impulsive sound pressure level in dB;

T is the measurement time interval in s;

$p_{\mathrm{AI}}(t)$ is the A-weighted instantaneous sound pressure using time weighting I (Impulse) in Pa;

p_0 the reference sound pressure; p_0. = 20 µPa.

3.12
noise with impulsive character
noise which contains an isolated event or a series of such events. The impulsive character is conventionally confirmed if the difference between $L_{p\mathrm{Aleq},T}$ and $L_{p\mathrm{Aeq},T}$ is greater than 3 dB

3.13
noise with tonal character
noise which contains audible tones

4 Measurement quantities

4.1 General

The quantities to be measured at all microphone positions for both type and monitoring tests are specified below.

4.2 Frequency analysis is required for type tests while it is optional for monitoring tests. The typical 1/3 octave band frequency range is from 31,5 Hz to 8 kHz according to EN ISO 266. It is important, however, that the lower frequency limit is chosen to ensure that the product of the lowest bandwidth and signal duration exceeds unity.

4.3 In presence of noise with suspected impulsive character, both $L_{p\mathrm{Aleq},T}$ and $L_{p\mathrm{Aeq},T}$ shall be measured. If they differ by more than 3 dB the impulsive character is conventionally confirmed.

4.4 In presence of noise with suspected tonal character, at each microphone position it is suggested to make frequency analysis measurements according to 4.2.

4.5 The measurement quantity for trains running at constant speed is the A-weighted equivalent continuous sound pressure level, $L_{p\mathrm{Aeq},T}$.

Additionally, the A-weighted short-term equivalent continuous sound pressure level, $L_{p\mathrm{Aeq,1s}}$ may be measured.

4.6 For measurements on stationary vehicles, in presence of noise with suspected impulsive character, at each microphone position it is suggested to make two measurements: one with time weighting slow S, the other with time weighting impulse I (see EN 61672-1).

4.7 The measuring quantities for accelerating or braking tests shall be the maximum AF-weighted sound pressure level, $L_{p\mathrm{AFmax}}$, and the A-weighted equivalent continuous sound pressure level, $L_{p\mathrm{Aeq},T}$. The measurement time interval,T is defined in Clause 7.

5 Instrumentation

The instrumentation system, including the microphones, cables and recording devices shall meet the requirements for a type 1 instrument specified in EN 61672-1.

The microphones shall have an essentially flat frequency response in a free sound field.

The one-third-octave band filters shall meet the requirements of class 1 according to EN 61260.

A windscreen shall always be fitted on the microphone.

Before and after each series of measurements, a sound calibrator with a class 1 accuracy according to EN 60942 shall be applied to the microphone(s) in order to verify the calibration of the entire measuring system at one or more frequencies over the frequency range of interest. If the difference between the two calibrations is more than 0,5 dB, all the measurement results shall be rejected.

The compliance of the calibrator with the requirements of EN 60942 shall be verified at least once a year. The compliance of the instrumentation system with the requirements of EN 61672-1 shall be verified at least every 2 years.

The date of the last verification of the compliance with the relevant European Standards shall be recorded.

6 Test conditions

6.1 Deviations from the requirements

The conditions prescribed for each test shall be complied with as closely as possible. Slight deviations from the specified test conditions are permissible, but shall be described in the test report and in general, will lower the reproducibility.

6.2 Test environment

6.2.1 Acoustical environment

The test site for chiefly outside-moving vehicles shall be such that the sound radiated by the vehicle to the outside contributes to the inside noise only by reflections from the track and not by reflections from buildings, walls or similar large objects outside the track.

For vehicles moving inside tunnels (like underground) the measurement shall be carried out in real operating conditions.

In the immediate vicinity of the track, there shall be no additional absorbent covering or snow.

6.2.2 Meteorological conditions

Measurements shall be made only if the wind speed measured at the microphone height is below 5 m/s and there is no falling rain or snow. Temperature, humidity, barometric pressure, wind speed and direction shall be described (possibly with measured values) in the test report.

6.2.3 Background sound pressure level

Care shall be taken to ensure that the noise from other sources (for example other vehicles or industrial plants) does not influence significantly the measurements.

For type tests, the A-weighted background sound pressure level shall be at least 10 dB below the reading of the A-weighted sound pressure level obtained when measuring the noise from the vehicle in the presence of

background noise. For frequency analysis this difference shall be at least 10 dB in each frequency band of interest.

For monitoring tests, the A-weighted background sound pressure level shall be at least 5 dB below the reading of the A-weighted sound pressure level obtained when measuring the noise from the vehicle in the presence of background noise. If this difference is less than 10 dB the reading shall be corrected according to Table 1.

NOTE If the above-mentioned difference is less than 5 dB a measurement of engineering grade (grade 2) is no longer possible.

Table 1 — Background noise correction for monitoring tests

Difference between the A-weighted sound pressure level obtained when measuring the noise inside the vehicle in the presence of background noise and the A-weighted background sound pressure level alone dB	**Correction to be added to the A-weighted sound pressure level obtained when measuring the interior vehicle noise in the presence of background noise** dB
>10	0
6 to 9	–1
5	–2

6.3 Microphone positions

6.3.1 General

The measured sound pressure level inside a vehicle may vary considerably with location.

In particular, above the wheelsets or underfloor auxiliary equipment a higher sound level is likely. Therefore, the number of measuring points selected shall be such that the sound level distribution in the vehicle is adequately represented.

In general, five to seven measuring points, which include the middle and the ends of the vehicle, will be sufficient. The exact microphone positions shall be indicated on a plan. Examples are shown in Figure 1.